GURME

The WMO GAW Urban Research Meteorological and Environmental Project

Purpose

The WMO GAW Urban Research Meteorology and Environment (GURME) project was recently started in response to the requests of the National Meteorological and Hydrological Services (NMHSs). NMHSs have an important role to play in the study and management of urban environments because they collect information and have capabilities that are essential to the forecasting of urban air pollution and the evaluation of the effects of different emission control strategies. The WMO established GURME as a means to help enhance the capabilities of NMHSs to handle meteorological and related aspects of urban pollution. GURME is designed to do this through co-ordination and focusing of present activities, as well as initiation of new ones.

Pilot Projects

Pilot projects are an important mechanism to promote urban activities. GURME promotes pilot projects that demonstrate how NMHSs can successfully expand their activities into urban environment issues, showcase new technologies at appropriate conferences, and develop illustrative examples. Present pilot projects include:

THE STUDY OF THE MECHANISMS CONTROLLING ATMOSPHERIC ENVIRONMENTAL POLLUTION IN BEIJING

This pilot project coordinated by the Chinese Meteorological Administration, is focused on improving the understanding of pollution formation in the atmosphere, the design of optimal schemes for monitoring and the forecasting of pollution events, and the fostering of improved prevention strategies.

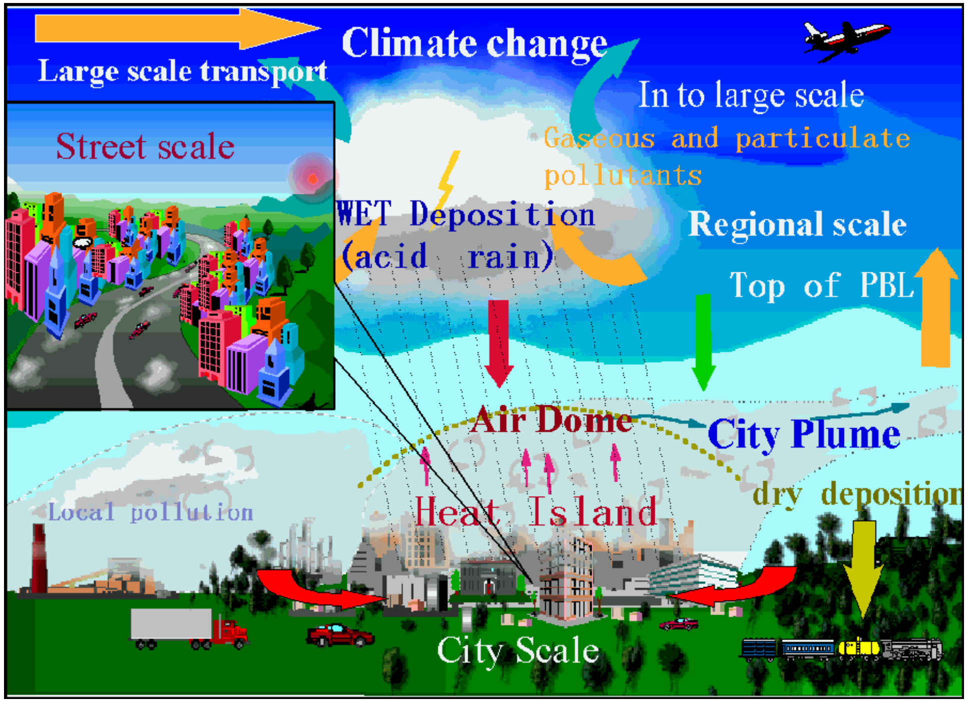
METEOROLOGICAL SERVICING FOR THE SUSTAINABLE DEVELOPMENT OF THE MOSCOW MEGALOPOLIS

This demonstration project coordinated by the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), is an integrated measurement and modeling study of the linkages between weather, air quality and climate in the Moscow environment.

Evgeny Kadygrov

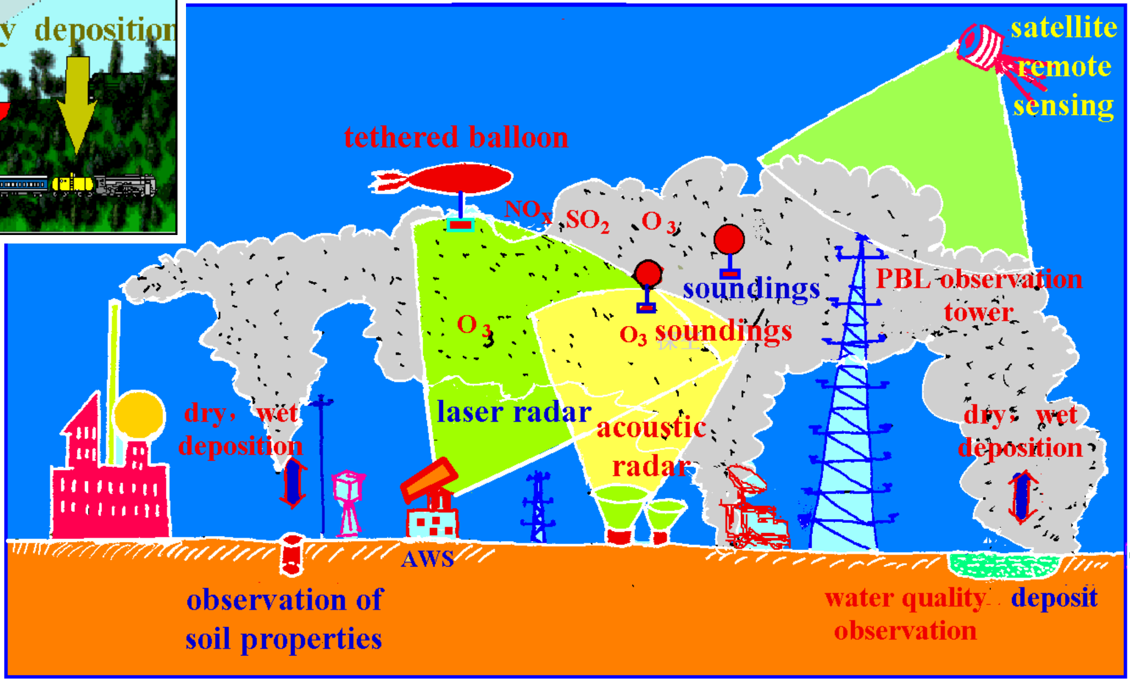
BEIJING PILOT PROJECT: THE STUDY OF MECHANISM ON ATMOSPHERIC ENVIRONMENTAL POLLUTION IN CAPITAL BEIJING.

GURME



Air pollution macroscopic temporal and spatial distributions and characteristics of atmospheric motion

Urban atmospheric environmental pollution monitoring system

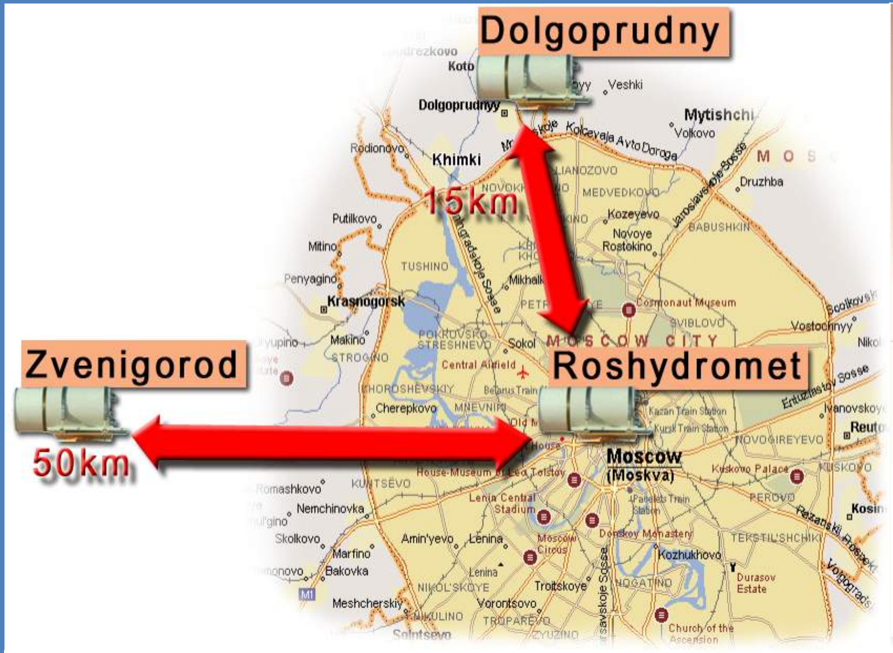


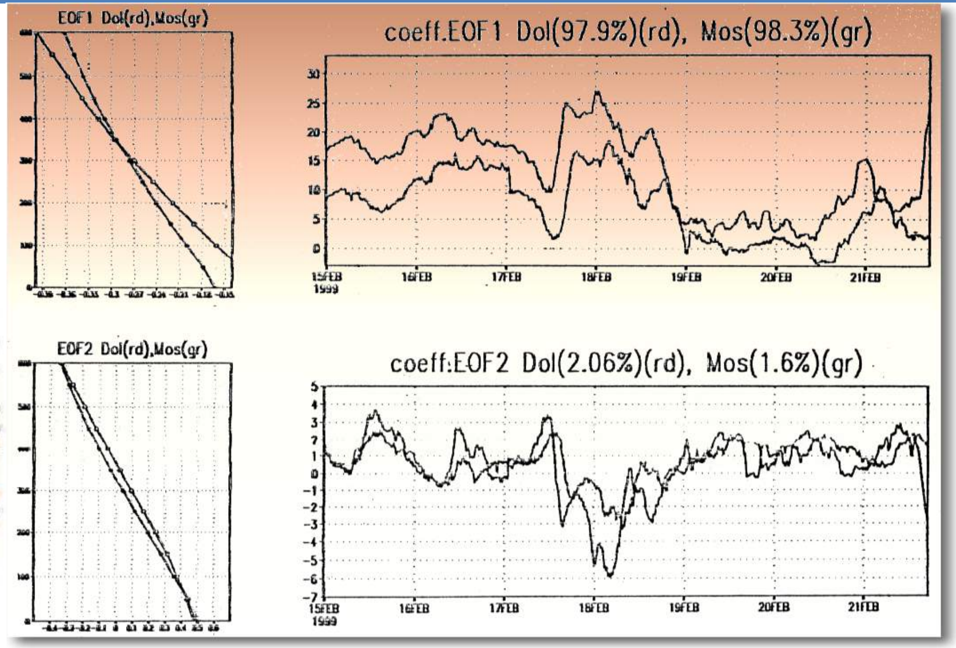
3-D soundings of atmospheric pollution in urban area

"Meteorological Servicing for Sustainable Development of the Moscow Megapolis"

Investigation of the urban heat island (UNI) on the base of microwave remote sensing data

GURME





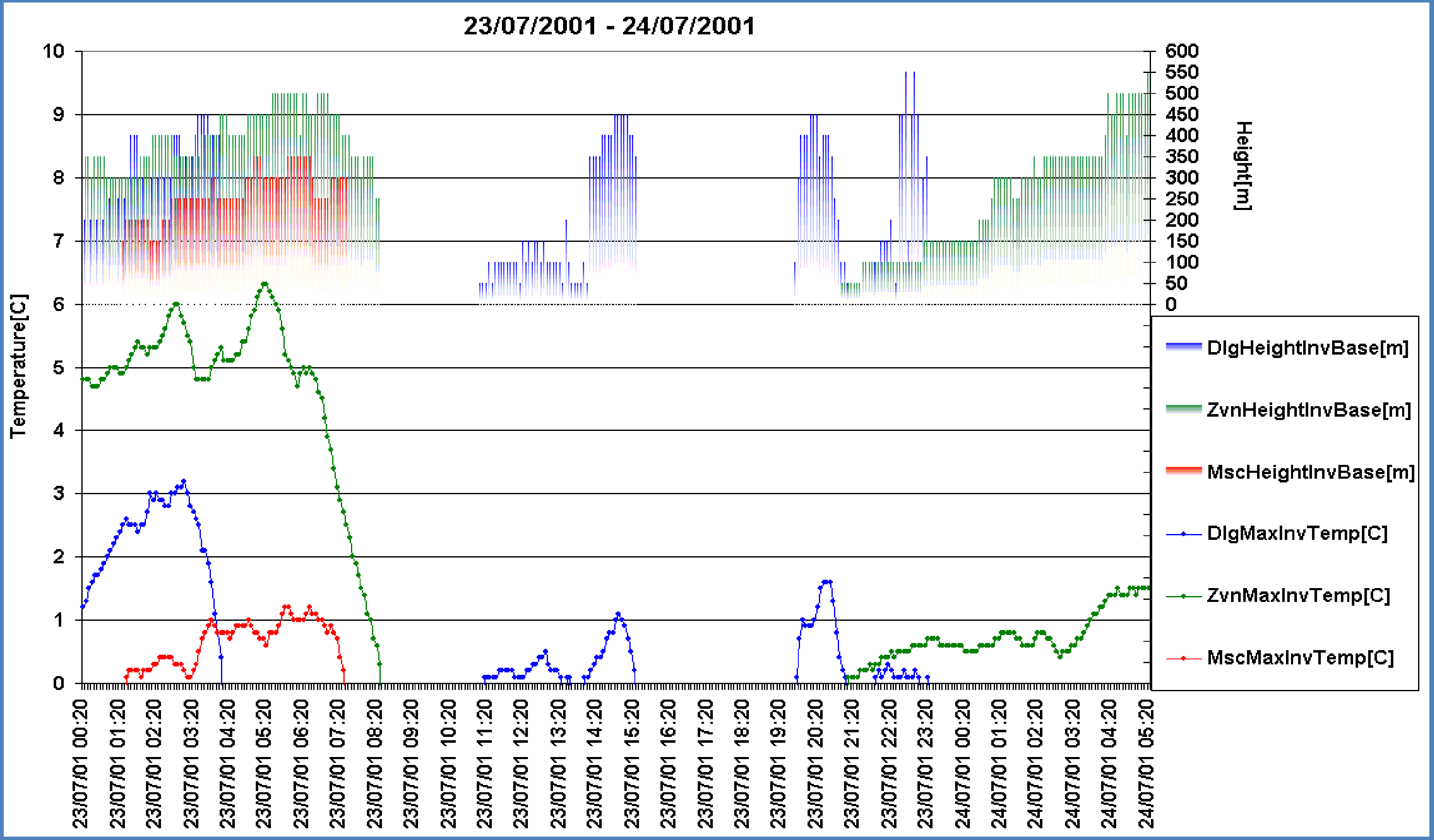
Simultaneous measurement of ABL temperature profiles over central and north (Dolgoprudny) part of Moscow city by the using of two MTP5 instruments started from 1 January, 2000. The measurement provided as a part of WMO pilot project GURME (Global Urban Research Meteorology and Environment WMO report, 1999). The distance between two MTP-5 instruments is about 15 km and measurements of ABL temperature profiles provided simultaneously each 15 min. One of the scientific objectivity of such measurement is determination of the influence of a big urban area to the boundary layer parameters. Analysis of the temperature profile variations (0-600 m) at Dolgoprudny and Moscow during February 15-22, 2000 indicated that the first empirical orthogonal function (EOF), (97.9%, 98,3% of the total variance respectively) shows the warming at Moscow in the 0-300 m and cooling in the 300-600 m layer in comparison with temperature variations at Dolgoprudny.

Calculated parameters.

To study of thermal field features in the megalopolis and its suburbs the following parameters were calculated:

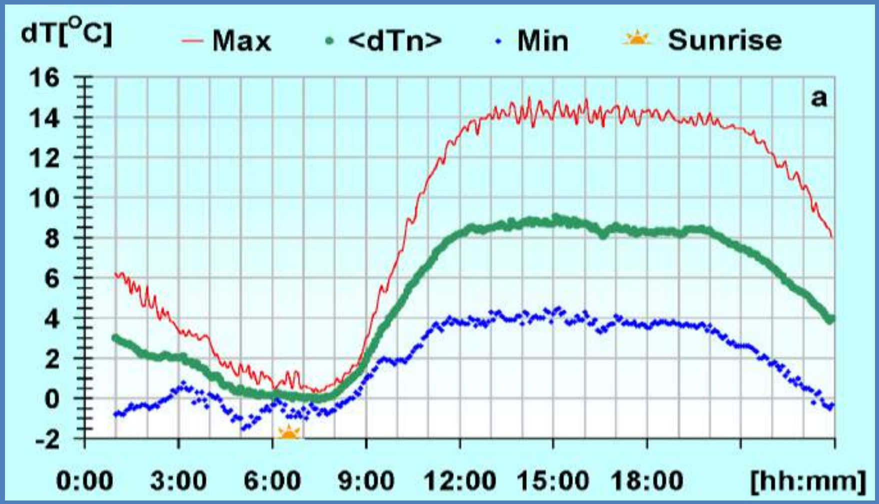
- normalized by daily minimum temperature $Tn_h(t)$ according to the equation $Tn_h(t)=T_h(t)-T_{min}$, where **t** local time (Moscow); $T_h(t)$ – temperature at level **h**=0, 100, 200, 300, 400, 500 and 600 m; T_{min} - daily minimum temperature.
- differences of normalized temperatures $Tn_h(t)$ between Zvenigorod and Moscow $dTn_h(t)= Tn_{h\ Zv}(t) - Tn_{h\ M}(t)$.
- averaged value of $dTn_h(t)$ for the stationary weather conditions $< dTn_h(t)>$. In average value calculations was noted that sunrise time was changing and a time scaling was done. Shifting was provided from early sunrise time to the later time.
- intradiurnal temperature changes $\Delta T_h(t_i)$ according to the equation $\Delta T_h(t_i)=T_h(t_i+1)-T_h(t_i)$, where i=0,1,2... 23 are the numbers of hour; t=0:30,1:30,2:30,...23:30 local time. $T_h(t_i)$ is the hourly averaged temperature at the i-th hour at the level h=0, 100, 200, 300, 400, 500 and 600 m.
- hourly averaged laps rate in the layers 0-100, 0-200, 0-300, 0-400, 0-500 and 0-600 m $\gamma_{h1-h2}(t_i)$ according to the equations $\gamma_{h1-h2}(t_i) = T_{h2}(t_i)-T_{h1}(t_i)$.
- monthly averaged value of the hourly averaged laps rate $< \gamma_{h1-h2}(t_i)>$.
- monthly averaged value of the intradiurnal temperature change $<\Delta T_h(t_i)>$. A correction for the sunrise time changes was not provided in this case because hourly average temperature was used for these calculations.
- differences of the hourly averaged temperatures between Moscow and Zvenigorod $\Delta T_{h\ M-Zv}(t_i)$ and Moscow and Dolgoprudny $\Delta T_{h\ M-Dl}(t_i)$ according to the equation: $\Delta T_{h\ M-Zv(Dl)}(t_i)=T_{h\ M}(t_i)-T_{h\ Zv(Dl)}(t_i)$, where i=0,1,2...23 are the numbers of hour; t_i =0:30; 1:30; 2:30... 23:30. $T_{h\ M}(t_i)$ is the mean temperature at the i-th hour at the level **h** in Moscow; $T_{h\ Zv(Dl)}(t_i)$ is the mean temperature at the i-th hour at the level **h** in Zvenigorod (Dolgoprudny); h=0, 100, 200, 300, 400, 500 and 600 m.

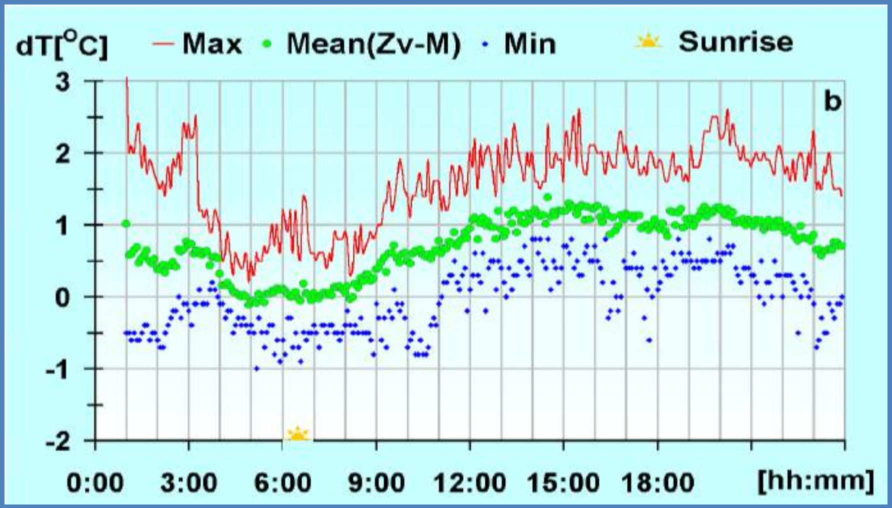
Investigation of the Moscow city heat island on the basis of simultaneous temperature profilers data

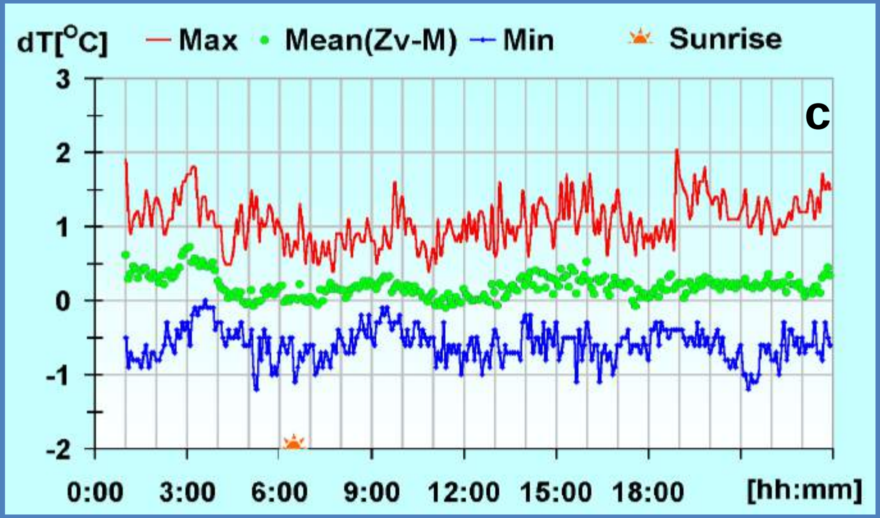


INVESTIGATION OF URBAN HEAT ISLAND ON THE BASIS OF STATIONARY AND MOBILE MICROWAVE SYSTEMS FOR REMOTE MEASUREMENTS OF ATMOSPHERIC TEMPERATURE PROFILE

Evgeny Kadygrov

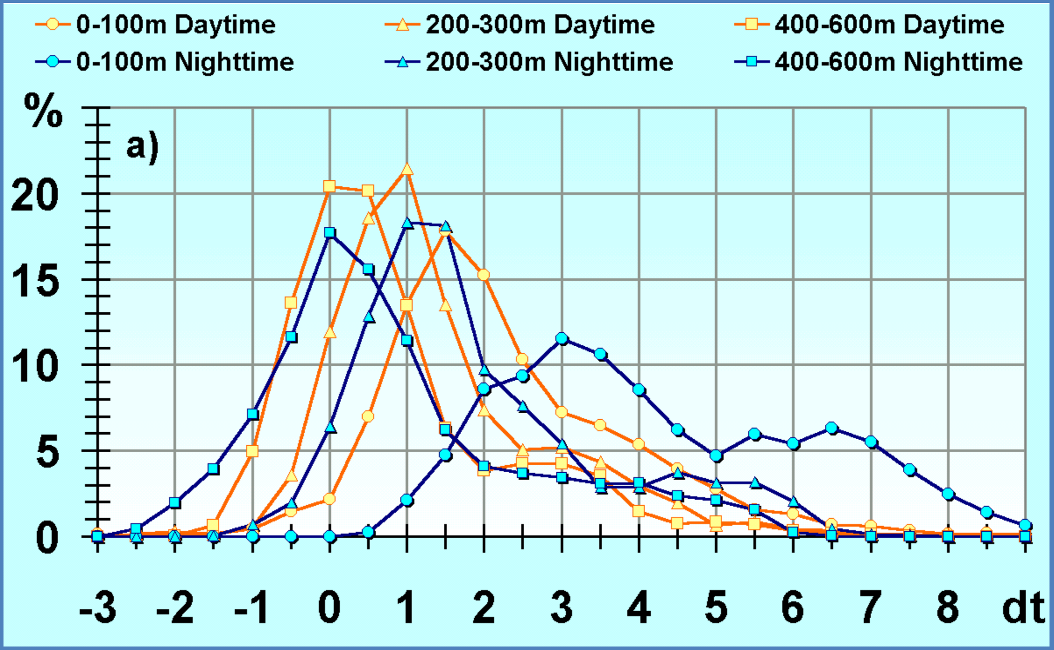


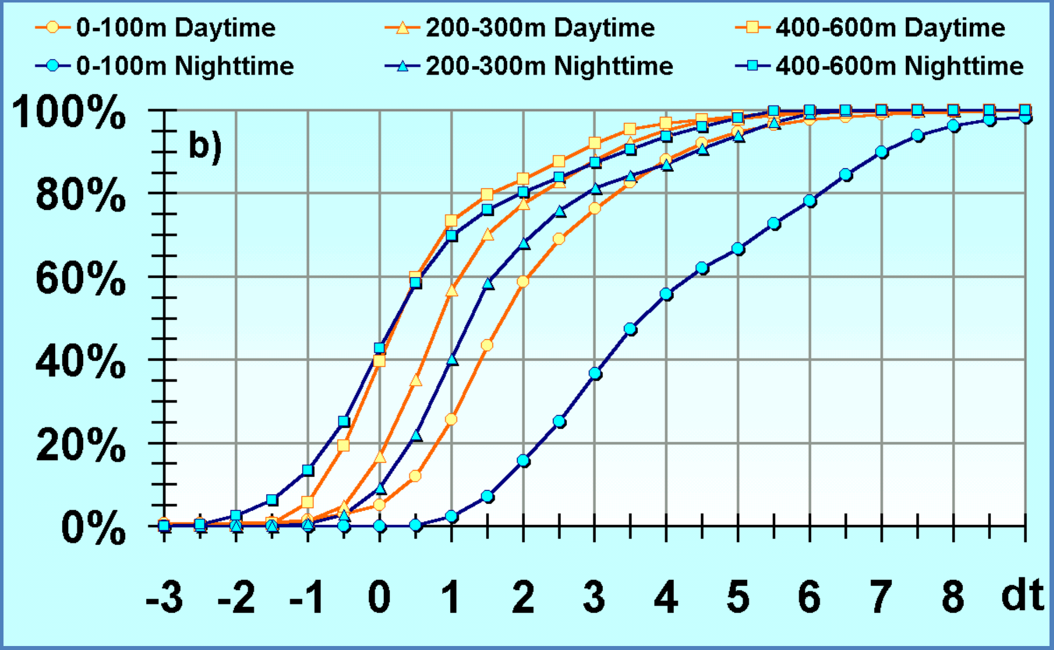




Changes of <dTnh(t)> at the levels a)- 0 m b) – 300 m and c) - 600 m for the steady weather conditions in May 2002.

Differences of normalized temperature ***$dTn_h(t)$*** in the large city (Moscow) and its suburb (Zvenigorod) is a clear illustration of the urban environment impact on the thermal mode of ABL (April – May 2002, steady weather conditions)





Distribution-a), and cumulative distribution –b) of the temperature difference between Moscow and Zvenigorod. June 2001. Daytime (6:00-21:00), nighttime (22:00-5:00).

Maximum of distribution at the layers lower than 400 m shifting to the right from day to night and from higher layers to the lower ones. The nocturnal city-suburb difference at layer 0-100 m was greater than 2^0C in more than 85% of the observed and it can increases up to 9^0C. City-suburb differences were less than –0,5^0C in the layer 0÷300 m in about 5% and at the higher layers (400÷600 m) in about 20% of the observed cases as in nighttime and in the daytime. A negative city-suburb differences were formed above the city in the layers 400÷600 m as in the nighttime and in daytime in about 40% of observed cases. The obtained distributions of temperature differences between Moscow and Zvenigorod at different levels show that thermal heterogeneity of ABL caused by the large city can exist practically under any weather conditions but with changes of its vertical structure and intensity.

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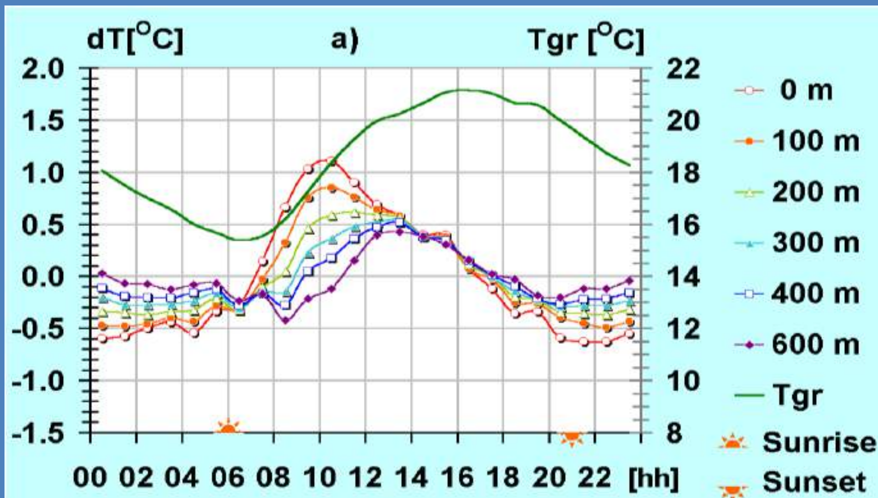
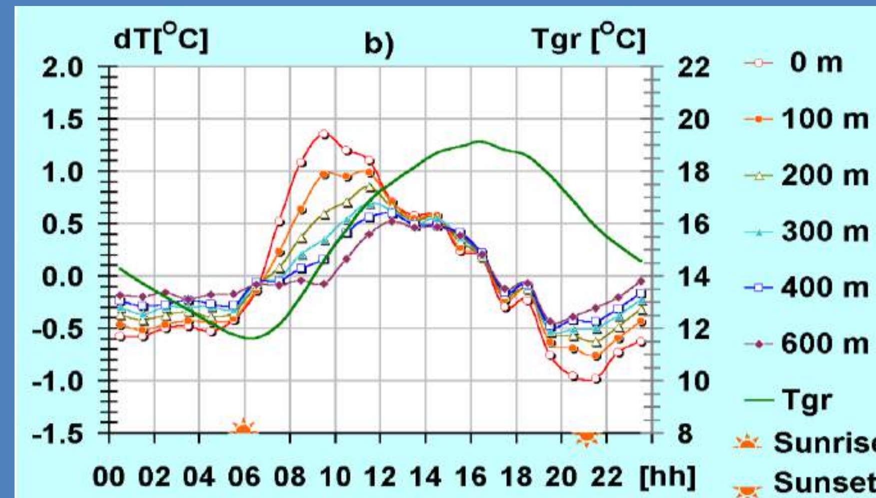
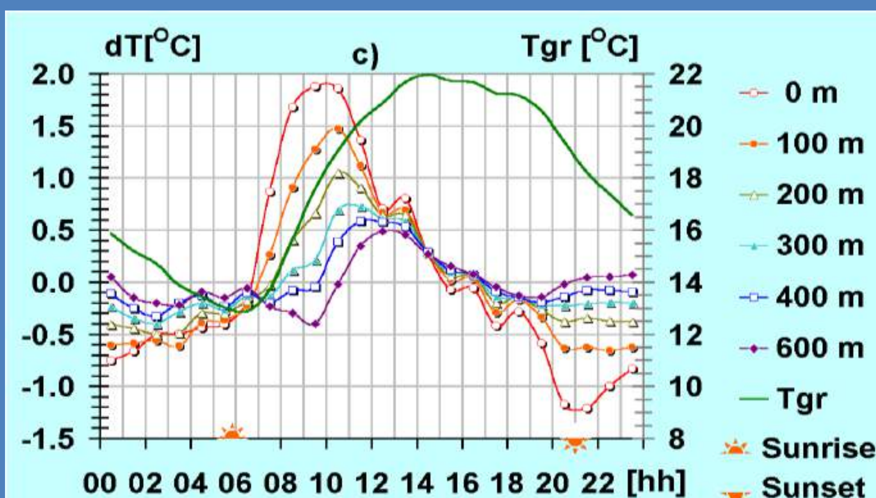
Evgeny
Kadygrov







Changes of <ΔTh(t)>. a)- Moscow; b)- Dolgoprudny; c)- Zvenigorod in three points. August 2001

The different signs of $< \Delta T_h(t) >$ trend indicate that temperature still decreases in the layer above 300 m at the time of warning-up of the lowest lager of the atmosphere under the normal conditions in the morning. The heating of the lower layer (lower that 300 m) in the urban ABL occurs slower than in the suburb.

The changes of <$\Delta T_h(t)$> from 6:30 up to 9:30 in three points for different layers and coefficient of linear approximation K[^{O}/km], calculated in these points.

Distance from Moscow [km]	Layer [m]						
	0	100	200	300	400	500	600
0 (Moscow)	1.3	1.0	0.8	0.5	0.3	0.2	0.4
20 (Dolgoprudny)	1.5	1.1	0.7	0.4	0.3	0.1	0.2
50 (Zvenigorod)	2.1	1.5	0.9	0.3	0.1	0.4	0.5
K of linear approximation [^{o}/km]	0.016	0.008	0.002	-0.004	-0.004	0.003	0.003

The heating rate in the layers 0÷100 m increases proportionally to the distance from the city. Such dependence did not observed in the higher layers. Thermal wave in the city reaches the upper levels of the measurement almost 1 hour later.

INVESTIGATION OF URBAN HEAT ISLAND ON THE BASIS OF STATIONARY AND MOBILE MICROWAVE SYSTEMS FOR REMOTE MEASUREMENTS OF ATMOSPHERIC TEMPERATURE PROFILE

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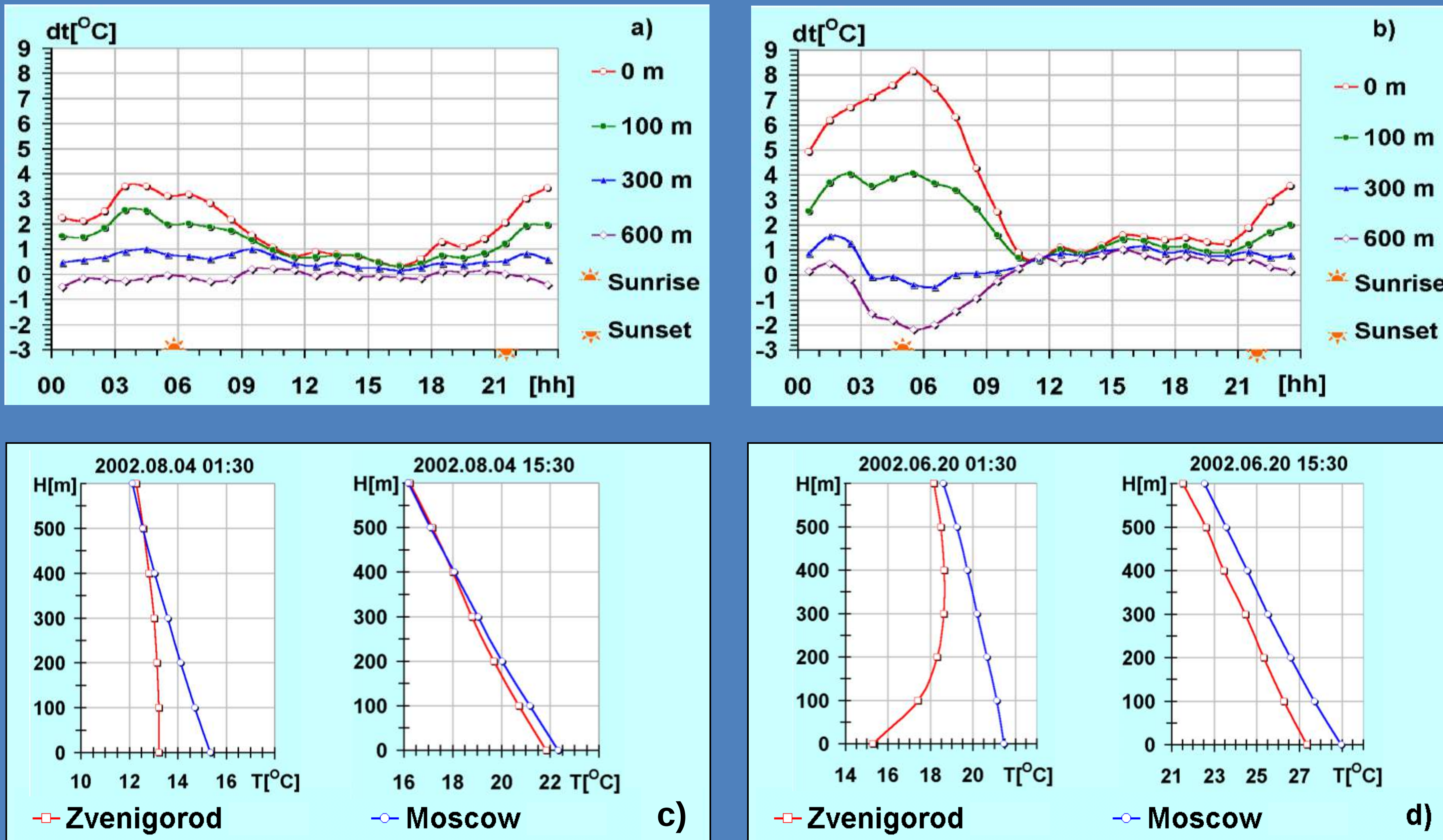
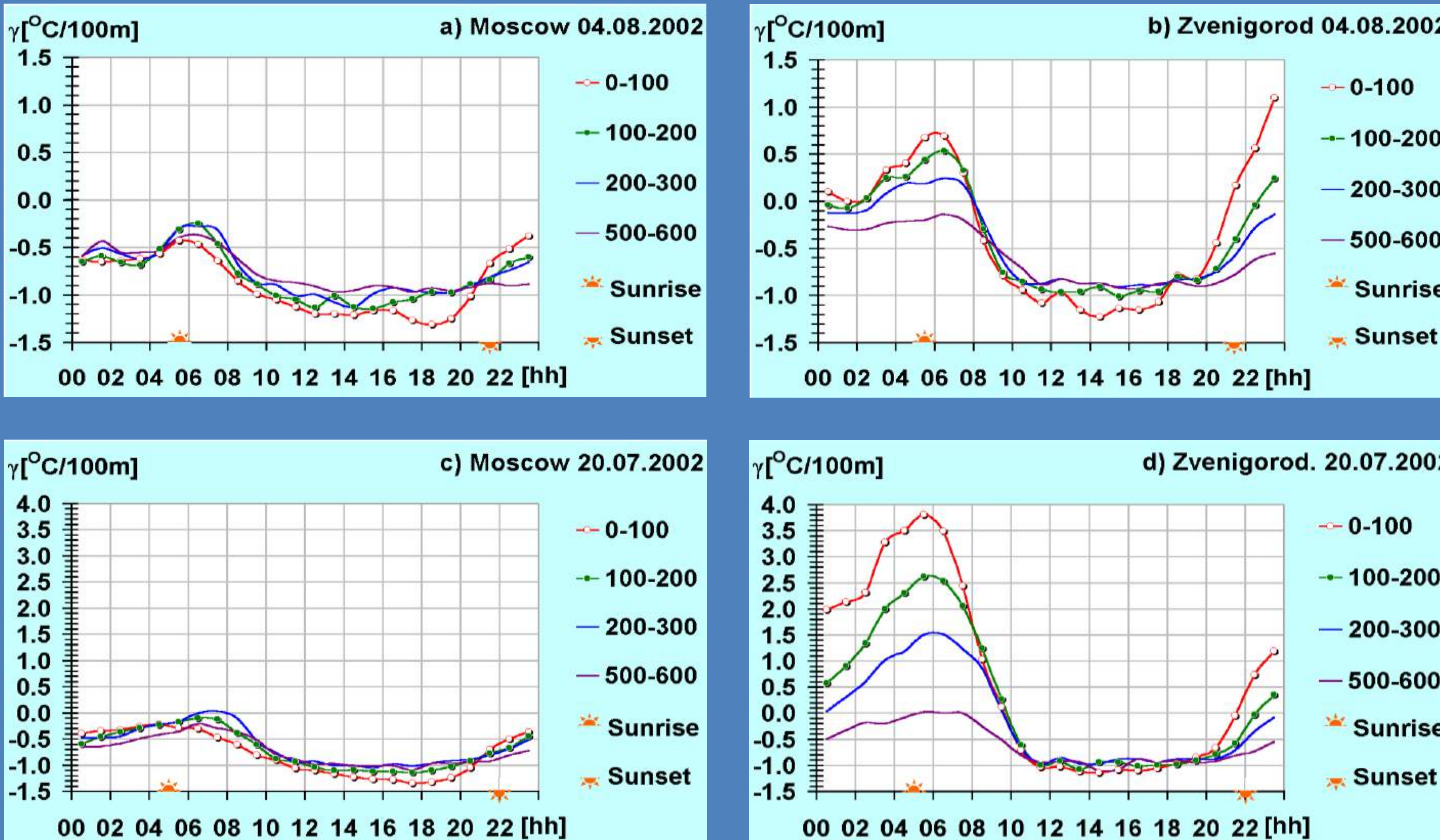


The difference of the hourly averaged temperatures between Moscow and Zvenigorod. a)-August 4, 2002; b)-July 20, 2002 and hourly averaged temperature profile in two points c)- August 4, 2002; d)-July 20, 2002
August 4, 2002 – relatively clean conditions; July 20, 2002 – high urban pollution level



Time dependence of hourly averaged lapse rate. a)- Moscow, August 4, 2002; b)-Zvenigorod. August 4, 2002; c)- Moscow, July 20, 2002; d)-Zvenigorod, July 20, 2002

August 4, 2002 - relatively clean conditions; July 20, 2002 – high urban pollution level. The influence of the megapolis on the thermal mode of ABL is well illustrated by the lapse rate change in the different layers.

INVESTIGATION OF URBAN HEAT ISLAND ON THE BASIS OF STATIONARY AND MOBILE MICROWAVE SYSTEMS FOR REMOTE MEASUREMENTS OF ATMOSPHERIC TEMPERATURE PROFILE

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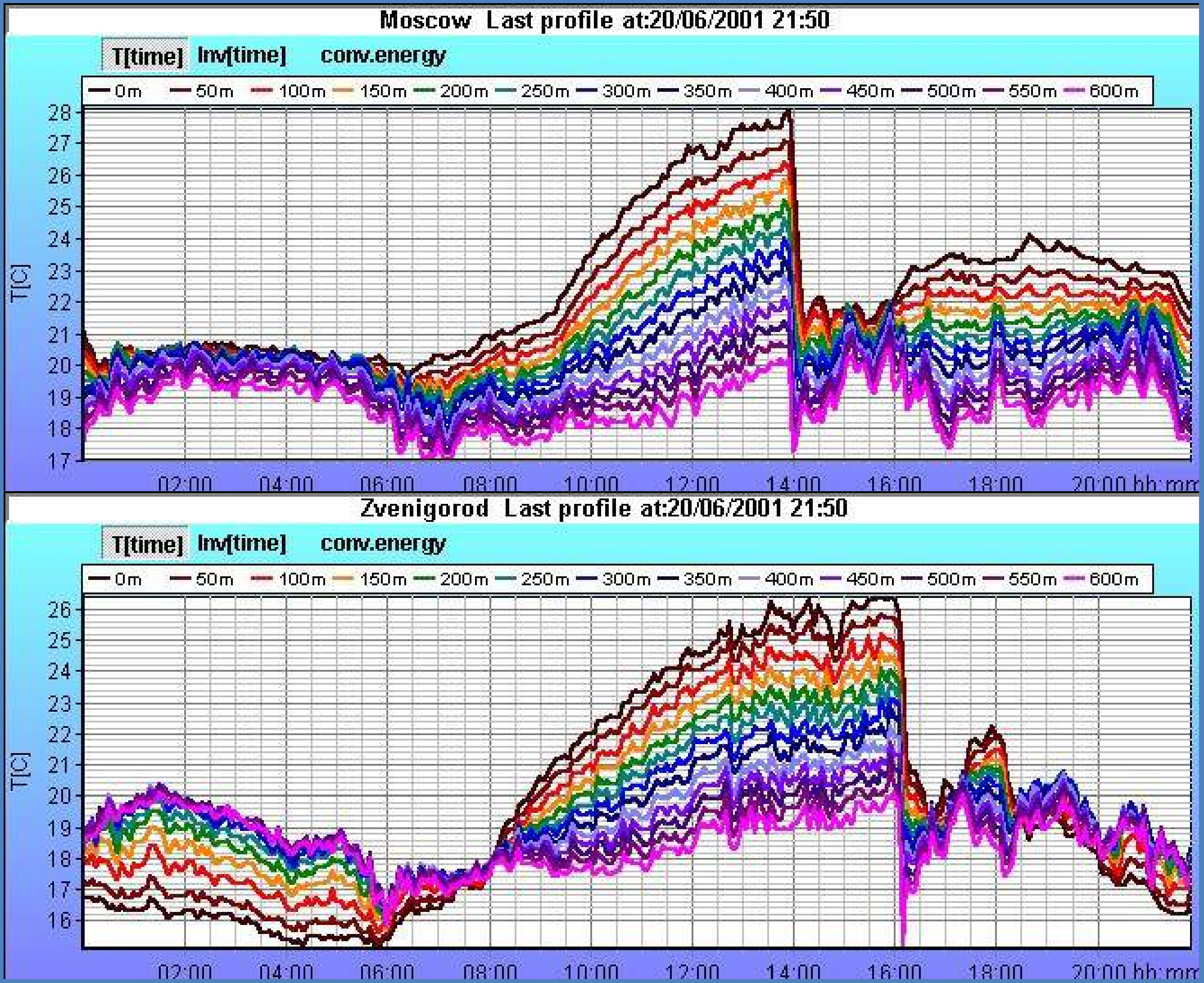
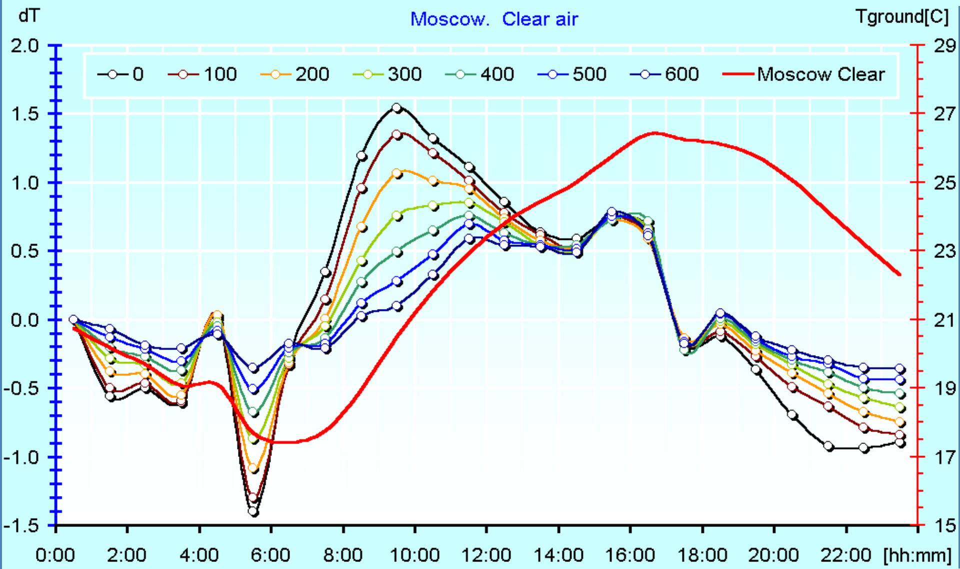


Temperature variations at different heights during the atmospheric front passage. a)-Moscow, b)-Zvenigorod. June 20, 2001.

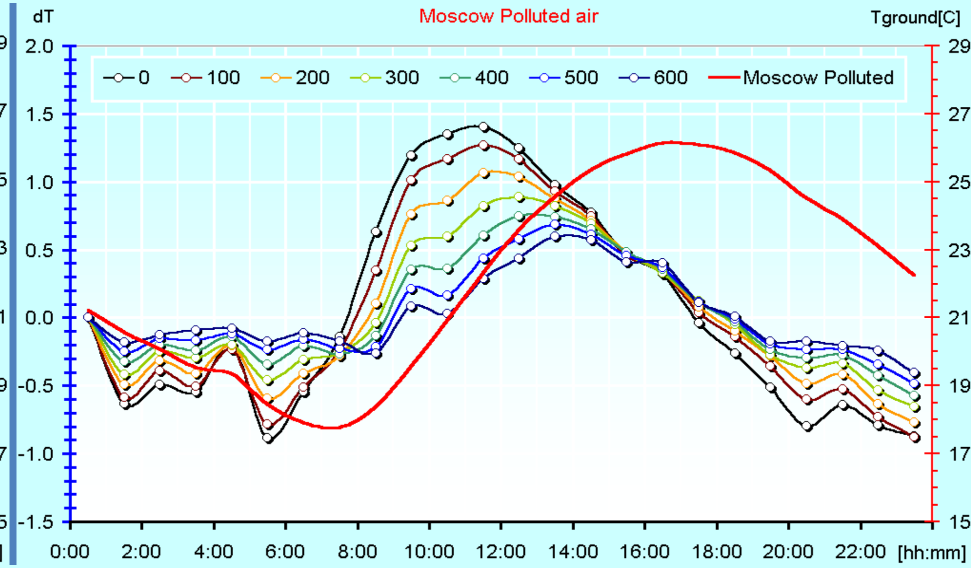
Data were obtained during the passage of the atmospheric front from the northeast through Moscow and Zvenigorod. Temperature jumps were observed in both cases. Partial restoration of UHI behind the atmospheric front was observed in megapolis. In half of an hour after the atmospheric front passage the temperature gradient decreased 3.7 times in Zvenigorod and became equal to 0.3 degree/100 m. In Moscow the gradient decreased only 2 times and it became equal to the moist-adiabatic one (0.6 degree/100 m).

Change of Atmospheric Boundary Layer Thermal Regime Induced by Aerosol as Measured by MTP-5

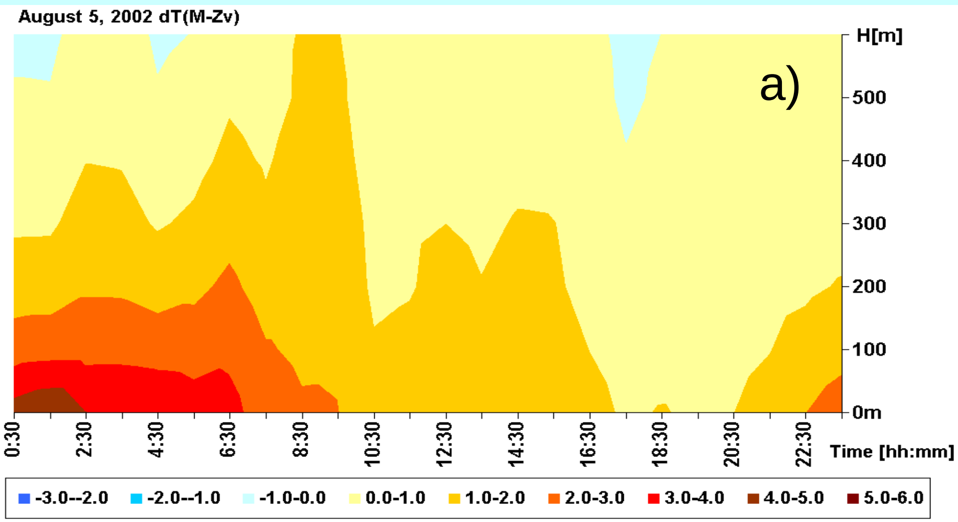
a) 2002.08.05

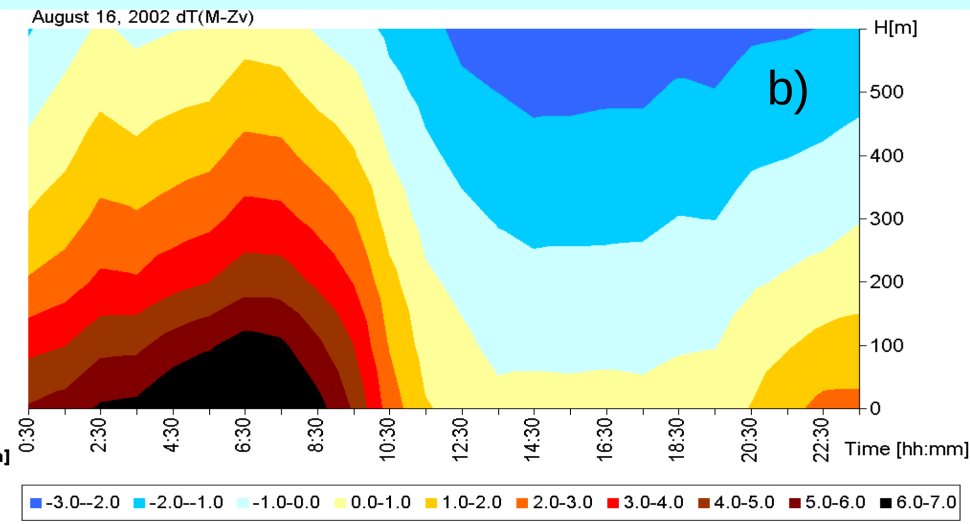


b) 2002.08.16



The change of $\Delta T_h(t_i)$ in Moscow. a) clear air; b) polluted air.





Color field of temperature difference (Moscow-Zvenigorod). a) clear air; b) polluted air.

Mobil Microwave Temperature Profiler (MMTP)

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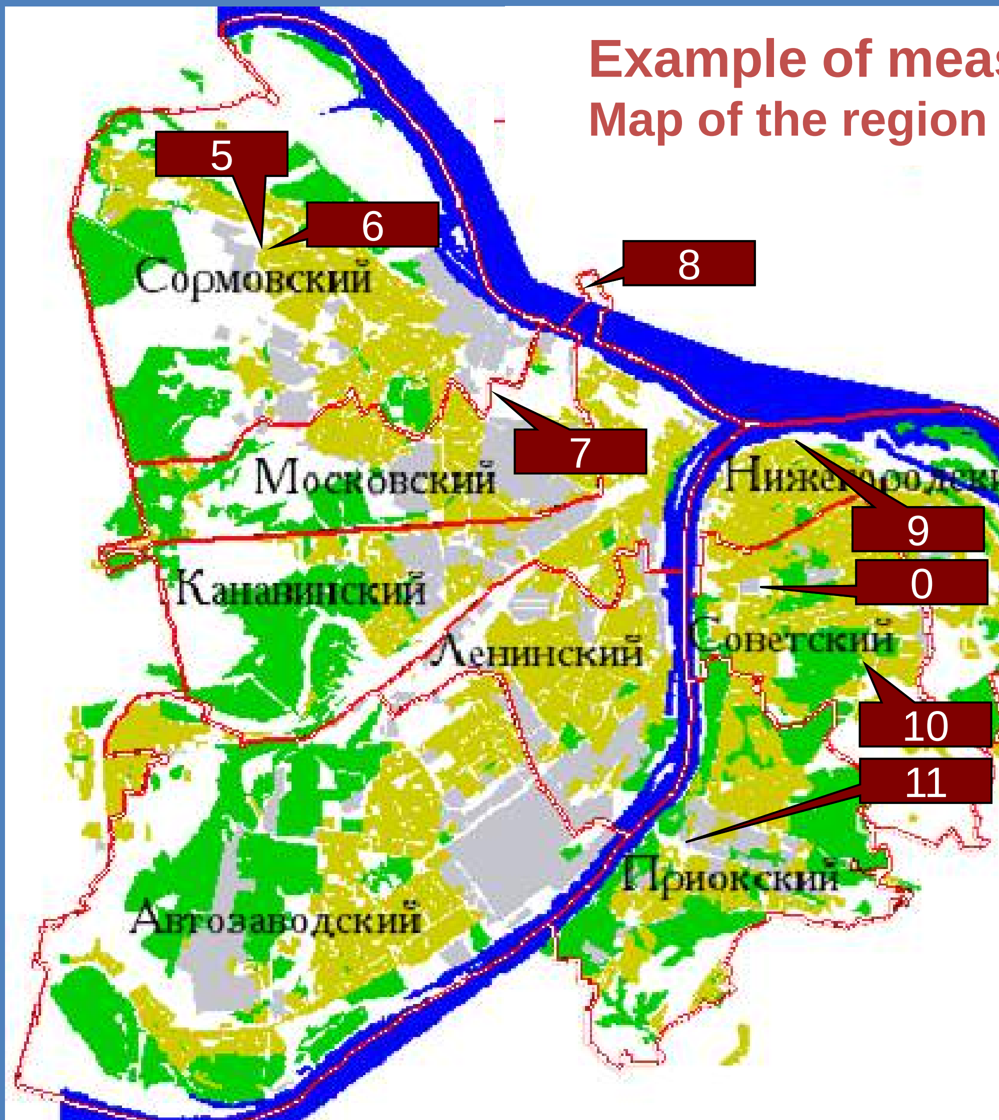
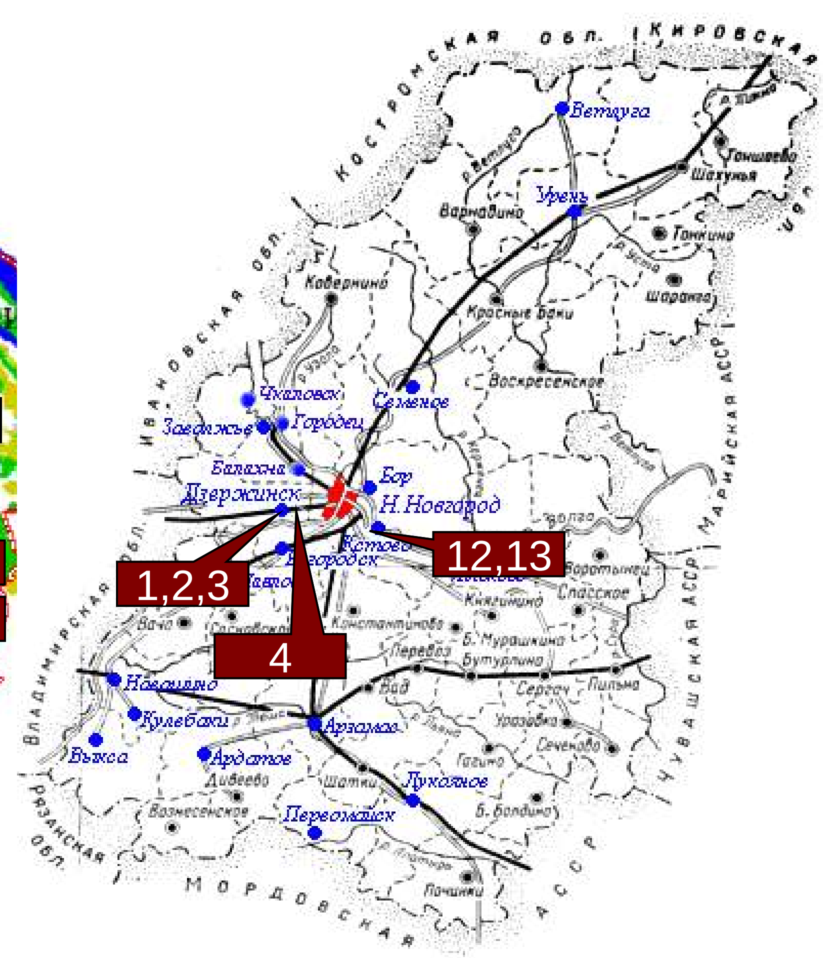
Example of measurements in Nijny Novgorod

Map of the region with the track of measurements





Composition of the system

MEDS

MMTP

METEO STATION

RADIO MODEM

GPS

Online of measurement in various points
Data collecting about parameters of an atmosphere
Transfer of the data to the dispatching centre

communication line

The dispatching centre of the analysis of the data and acceptance of the decision about the protocol of measurements

The primary analysis of the data and quality control

The software of processing and representation of the data

REPER POINT MTP5

MTP5

Data collecting in a stationary mode

Transfer of the data to the dispatching centre

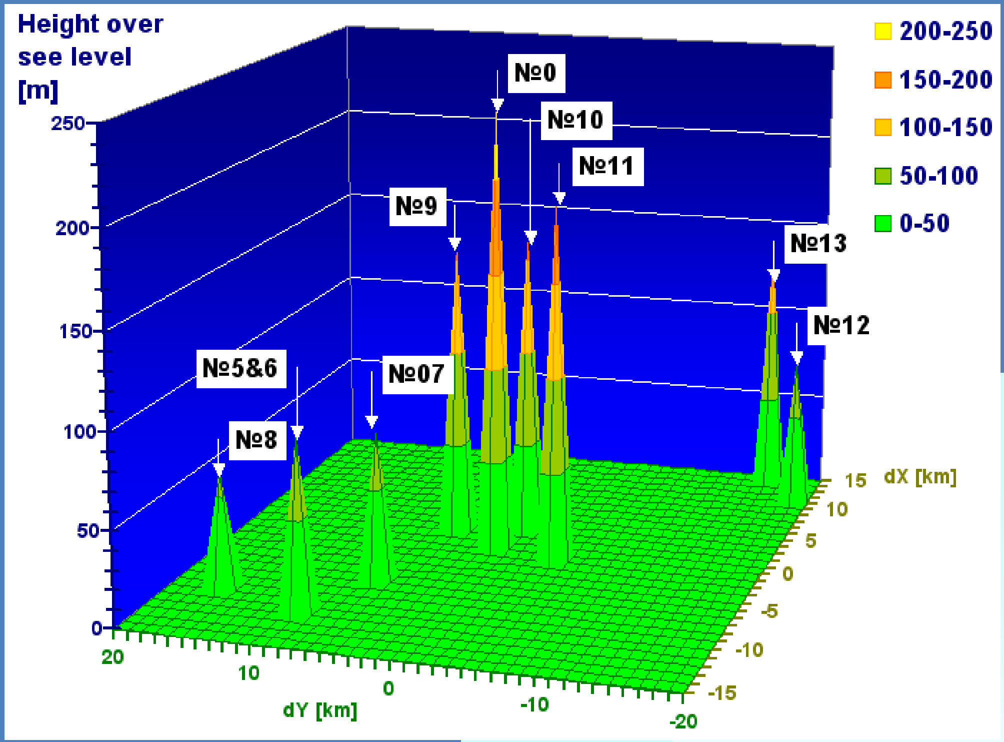
Display of the cartographical information

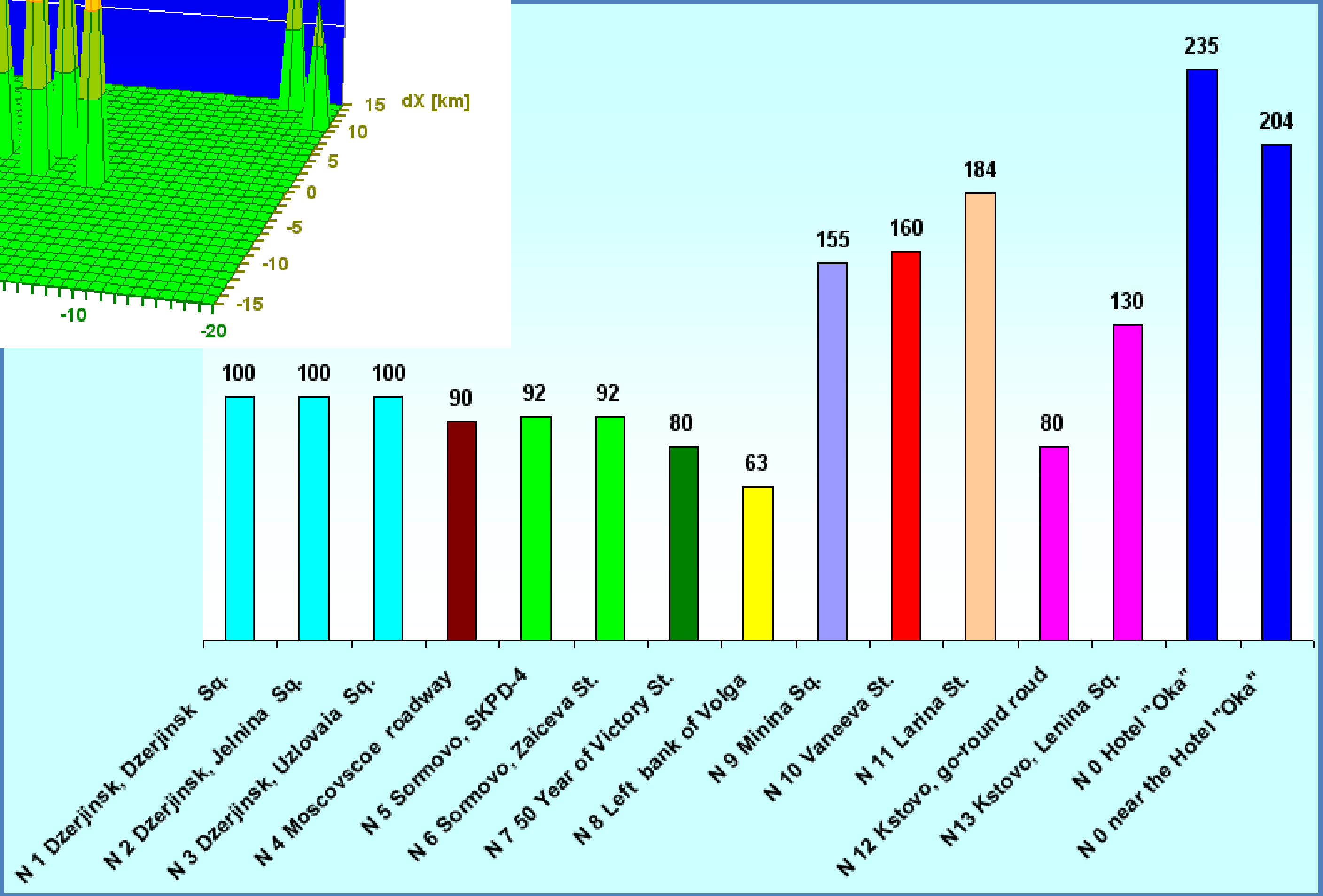
Display of results of measurement of a mobile complex in online a mode as the time and space crossection diagrams

The analysis of comparison of the data MMTP and stationary MTP-5

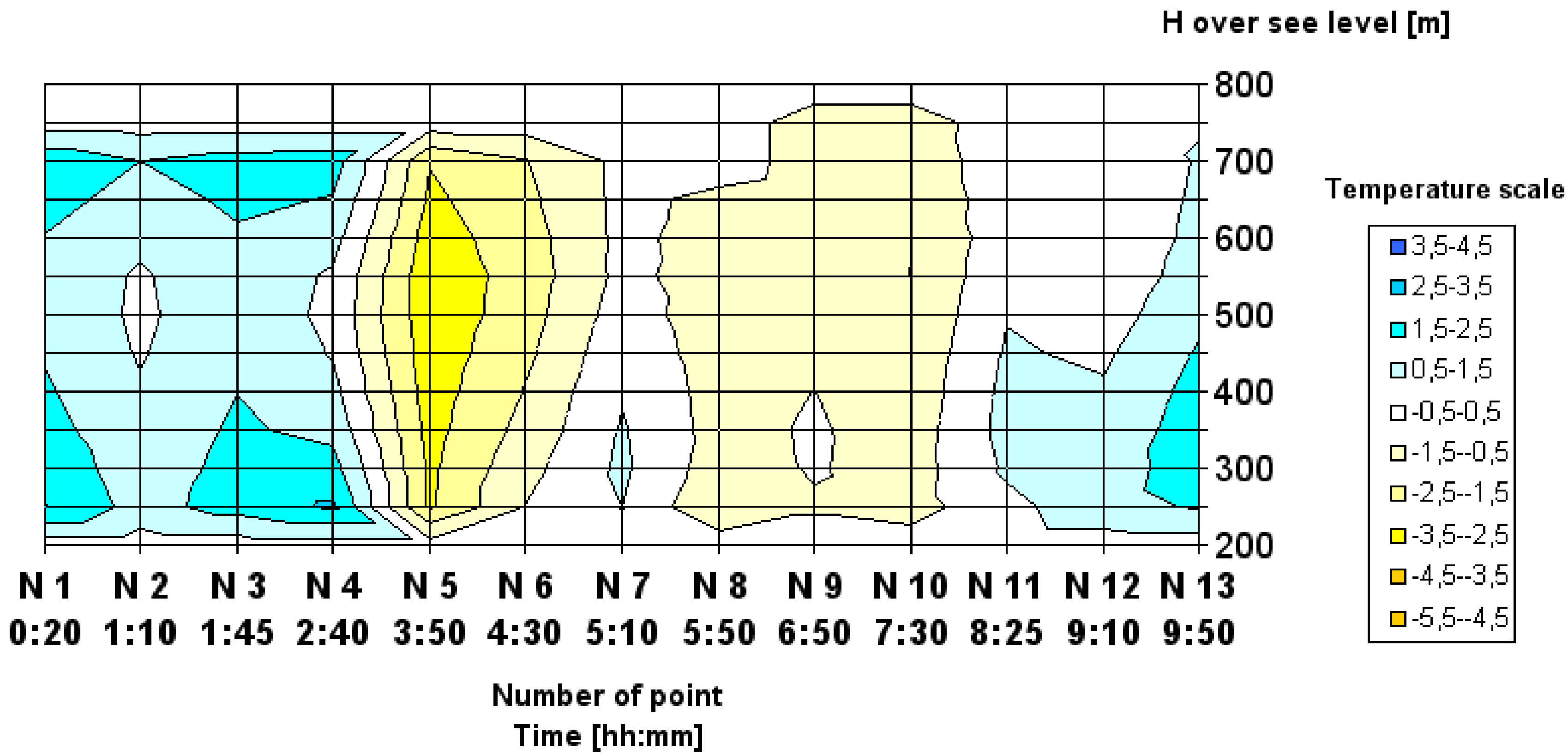
Package of the control of adverse conditions and short-term forecast

Altutudes and positions of measuring points in Nijni Novgorod



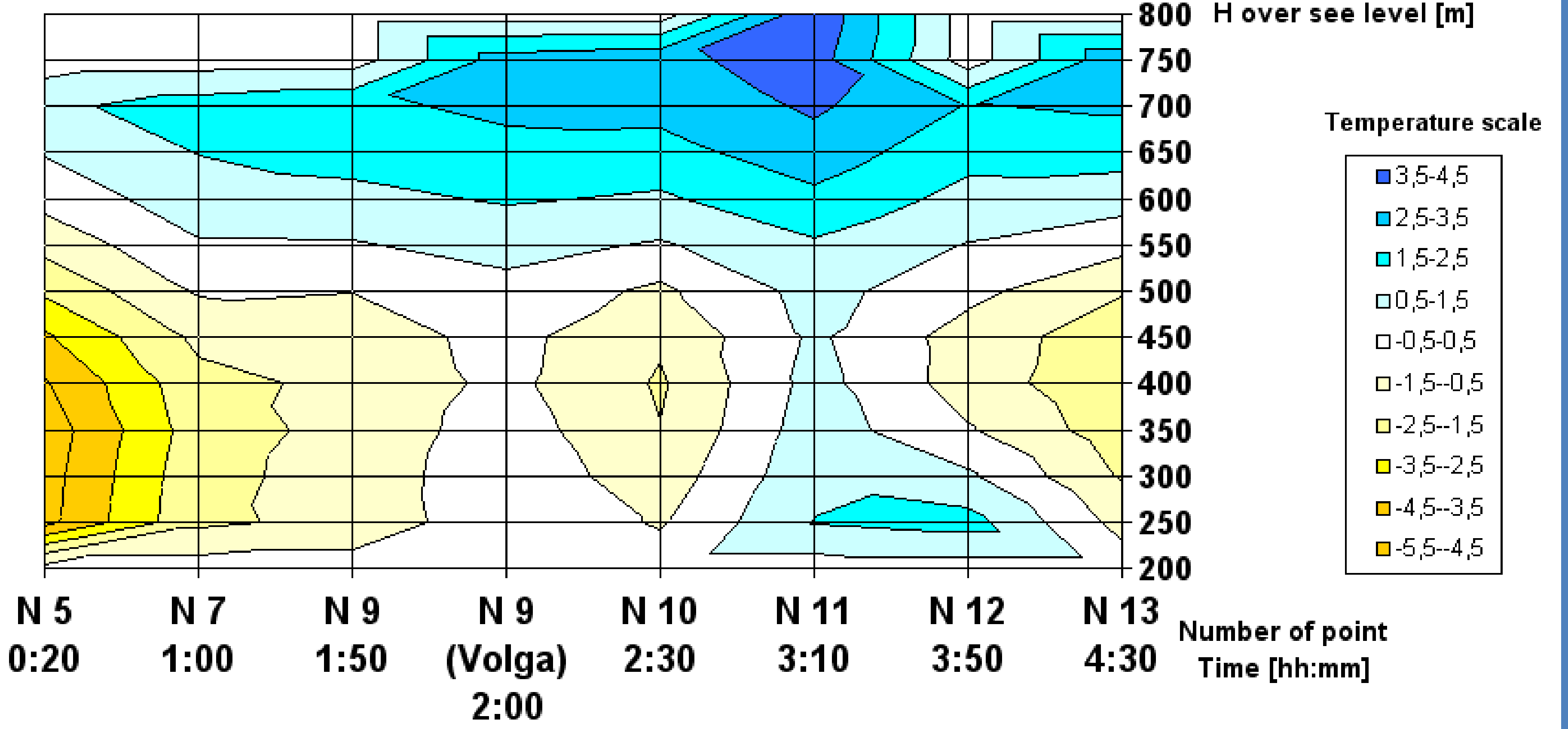


Field of temperature difference measured by MTP-5, installed in Hotel "Oka" (N 0), and MMTP-5 in different points (N1-N13). August 6, 2004



Anticiclone conditions, wind speed < 1m/c in the layer 0-900 m

Field of temperature difference measured by MTP-5, installed in Hotel "Oka" (N 0), and MMTP-5 in different points (N5-N13). August 7, 2004



Anticiclone conditions, wind speed < 1m/c in the layer 0-600 m and 3-6 m/c in the layer 600-900 m

SUMMARY AND CONCLUSIONS

Continuous temperature profiles observations in atmospheric boundary layer on the basis of stationary and mobile microwave profilers allow to obtain unique data and to investigate the UHI over the big cities.

Two types of UHI were identified on the basis of the temperature profile measurements: the warmer dome of the urban heat at all levels, and low warmer dome in combination with the lens of the cold air above it. The lens of cold, placed under the dome is a result of both radiation balance deformation in more humid and polluted urban air and more active mixing processes in more unstable urban air.

UHI exists not only under the conditions accompanied by the elevated pollution levels, but also under that one when relatively clear air does not accumulate urban polluting outbreaks.

The most pronounced UHI is observed in the morning and at night. The accumulation of the pollutants and water vapor in the urban air occurs this time and UHI reaches its maximal intensity. During the day the UHI is broken down or remains only in the low 300 meters.